THE TELEGRAPHIC JOURNAL.

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POSTAL TELEGRAPH ACCOUNTS.

THE reader interested in public accounts is just now in an unenviable position. A great breach of discipline is presented to him, and he does not know whom to blame. To apportion censure amongst many, according to the degree of delinquency, is an exceedingly difficult task, and, when accomplished, is seldom productive of satisfactory result. In the matter of the Postal Telegraph Accounts this apportioning of censure is most difficult. The department is a new one. Its operations are without precedent. Important beyond measure, its temporary failure or decline would infallibly result in commercial crisis. The old tale of money wanted and money at hand, parliamentary routine and insufficient estimate, and the story—it is trite now—is told.

The error detected, forthwith the Secretary is called to account. Justly; but where are the Directors? Ordinary commercial routine would indicate Mr. Monsell, managing director. But Mr. Scudamore exonerates the managing director, and leaves us face to face with the Commissioners of National Debt, who, having little else to do than manage the Savings Banks' deposits, should have enquired what had become of their money. But the *ignus fatui* is not yet captured, and we stumble against the Treasury. This department, however, has to control a great number of other departments, and we are compelled to remit somewhat of the blame, which falls the more heavily upon the National Debt Commissioners and the Postmaster-General.

The point at issue, however, is the restoration of public confidence in public accounts, and this can only be effected by the most stringent examination into the causes of the aberration discussed in the House of Commons. While there exists less certainty in the management of public accounts than in the checking of accounts in the office of a merchant or of a company, the public will not be satisfied. Great as is the postal department, admirably as it has been worked, its ways must be now plainly mapped out and its surplus energy curtailed. And this must be the ultimate result of Mr. Cross's question of inquiry put before the House on Tuesday's sitting. Mr. Cross's resolution, "that the House records its disapproval," was, however, too severe; for notwithstanding that great irregularities existed, it was the routine, and not the exception, that stood in the way; for the so-called "irregularities" ("misappropriation" is much too harsh a term) occurred in the public good. The amendment moved by Sir John Lubbock, "that this House regrets to find, from the reports of the Committee on Public Accounts, that the Post Office revenue and Savings' Bank balances have been largely employed for the purposes of telegraph capital expenditure without the authority of Parliament, and is of opinion that it is the duty of the Government to take effectual measures to prevent the recurrence of such a proceeding," is a sufficient expression of regret, with which the public will be satisfied.

The question arises now, is it well to encumber the Postmaster-General, who has onerous duties to discharge, with telegraphic affairs? Why should there not be a telegraphic commander-in-chief? The Telegraphic service will ere long fully rival the Postal service; for the present financial estimates include the idea of still wider extension of our telegraphs. In the discussion Mr. Monsell added only weight to the idea that the Telegraphs need a representative head, by saying—"Unless Mr. Scudamore had been left in a position of independence greater than that usually allowed to a subordinate, the enterprise entrusted to him could not have been executed, nor would England have achieved the distinction of having the best telegraphic service in the world." While it is evident that the Postmaster-General never could nor can exercise, with advantage to the public, control in the telegraph department.

As for Mr. Scudamore himself, the whole of the transaction shows that he ought to have held and ought to hold a position much less hampered by routine, or that this routine should be as swift and prompt as he would wish it to be. "The conduct of Mr. Scudamore," says Mr. Gladstone, "may be a very proper subject for animadversion, but Mr. Scudamore is no fit subject for the censure of the House. It is the political officers who stand between the permanent officers and its censure. Mr. Scudamore has committed a great error, but that error is balanced by still greater services; and upon the merits of this case I refuse to censure Mr. Scudamore. What I stand upon with those who are not so well aware as myself of the great services of Mr. Scudamore is that we should do wrong to adopt a motion which does not confine the sweep of its censure to political officers, but includes within it these important permanent servants of the Post Office." An unpleasant but necessary inquiry cannot be better brought to a close than by congratulations to the public that it possesses in so onerous a department so honourable and so able a servant.

PRIZES TO STUDENTS.

It has been decided to offer, from time to time, to our Students, prizes for the best and most carefully considered paper on a given subject. By the kindness and courtesy of Mr. Robert Sabine, C.E., who has placed the funds at our disposal, we are enabled to commence the series with a

PRIZE OF £25,

to be awarded to the Author of the best paper on "*The Evidence of the Theory of Correlation of Physical Forces as applied to Electricity and Magnetism,*" received by the Editor of this Journal on or before January 1st, 1874.

Each paper submitted for competition must describe original experiments.*

Each paper to bear (on every leaf) some word or motto by which it may be recognised. The same word or motto to be inscribed on a sealed envelope containing real name and address of competitor. The papers not selected will be destroyed with the envelopes unopened.

Papers to be addressed to the Editor, and endorsed "Students' Prize."

The best papers will be selected, and submitted to a Committee of well-known Electrical Authorities (whose names will be published), who will award the prize for the most carefully prepared paper, irrespective of the view taken by its Author, whether favourable or unfavourable to the new theory.

The Prize Paper to be printed in the columns of this Journal.

TELEGRAPHIC MESSAGES.—In the House of Commons, on Monday last, Mr. Alderman Lawrence asked the Postmaster-General whether he would consider the expediency of authorising, for the benefit of the Revenue and of the public, the sender of a telegram to receive a reply not exceeding ten words on the payment of an additional 6d. Mr. Monsell replied that he had made inquiries on the subject, and was sorry to say that it would not be advisable to take the course indicated. The Department are put to exactly as much trouble in sending a reply as in sending the original message, and they did not believe the number of replies would be much increased by the reduction proposed.

TELEGRAPH MATTERS IN CHILI.—At a meeting of the directory of the Transandine Telegraph Company, held recently at Valparaiso, it was stated that the business of the Company was steadily increasing, and it would soon be possible to declare a dividend. It was also stated that the Brazilian and Lisbon cable would be laid and opened as far as St. Vincent, Cape de Verde, in September next, and that the construction of the Pernambuco cable would be completed by May, 1874, so that in about one year Chili will be in telegraphic communication with the world.

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* We do not wish to direct the nature of the experiments which the student should make, nor to confine him to any general disposition of his paper. As a guide, however, we shall give in our next number such a series as we should make, were we ourselves competing for the prize.

DUPLEX TELEGRAPHY.

By **W. H. PREECE**, Memb. Inst. C.E. and Soc. T.E.

(Continued from page 199).

HAVING endeavoured to explain Gintl's original solution of the apparently impossible problem of duplex telegraphy, I must now describe the second method, or that of *difference*, which was the modification of Gintl's original plan, introduced simultaneously and independently of each other by Siemens and Frischen, in 1854.

2. *Difference.*

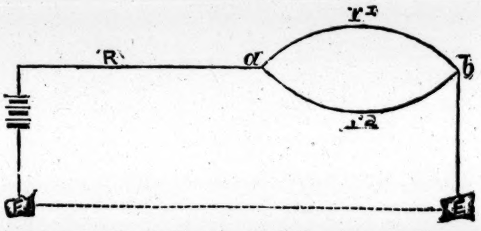
In this method, the double contact key and equating battery are dispensed with, ordinary keys and a single battery are used, and simple means are introduced to adjust the apparatus against the effects of the constant changes in the resistance of the line wire due to the variation of the temperature and the moisture of the atmosphere.

A still further modification, based on this principle of difference, has recently been introduced in America by Mr. Stearns, and independently, but subsequently, in England by Mr. Eden.

The first system (Siemens-Frischen) is dependent upon the principle of the *differential galvanometer* (*a*), and the second system (Stearns') upon that of the *Wheatstone Bridge* (*b*).

(*a*). *The differential principle.*—If two circuits be open to a current, it will divide itself between them in the inverse ratio of their resistances, the greater current being in the circuit of the smaller resistance, and *vice versâ*. If r_1 and r_2 (Fig. 1) be the resistances of the two wires connecting *a* and *b*, and c_1 and c_2 the currents flowing in each, then—

FIG. 1.



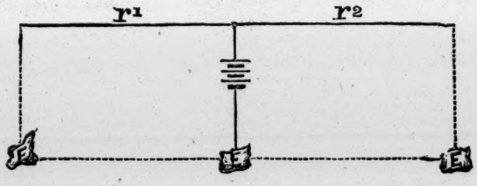
$$c_1 : c_2 :: r_2 : r_1$$

$$\text{or, } \frac{c_1}{c_2} = \frac{r_2}{r_1},$$

$$\text{and } c_1 r_1 = c_2 r_2.$$

Hence, if the two circuits are exactly equal in resistance, the currents in each must necessarily be equal. Similarly, if r_1 and r_2 (Fig. 2) be equal in resistance, the currents in each will be equal.

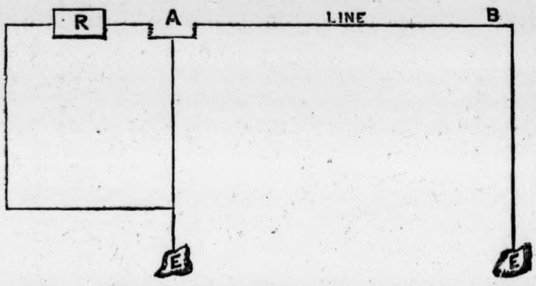
FIG. 2.



If, at station A (Fig. 3), we arrange two circuits open to the current intended to register marks at station B, the one—the main circuit—through the line wire, and the other—a derived circuit—through the artificial resistance coils, R, as long as these two circuits offer equal opposition, the current through each will be equal and similar;

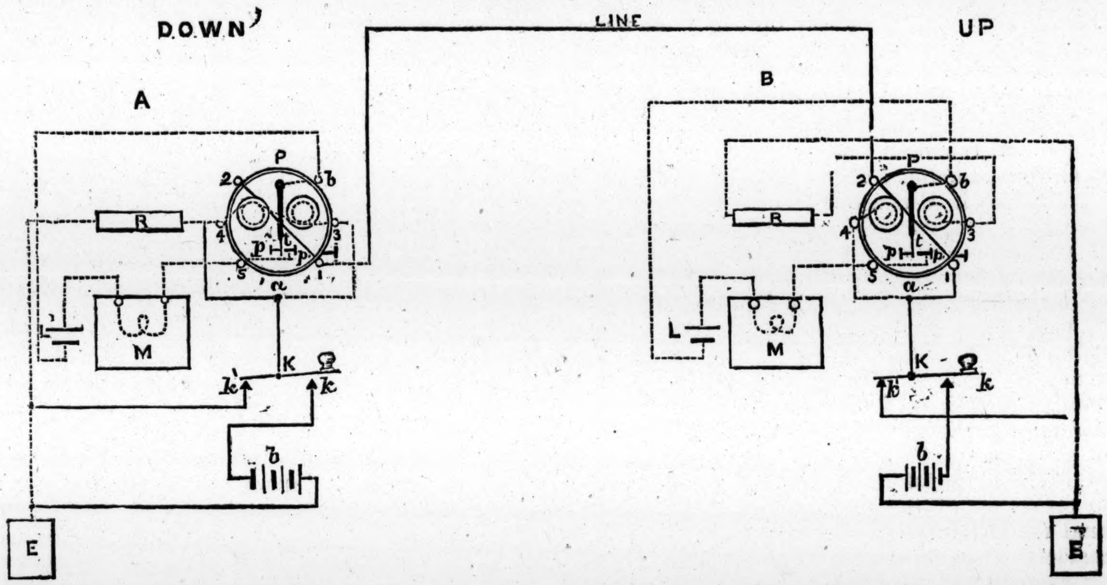
so that if the line current traverse one wire of the receiver, whose electro-magnet is constructed of two similar wires, like that illustrated in Fig. 3, in one direction, and the second current traverse the second wire in the opposite direction, then, under similar conditions, the effect on A's receiver will be *nil*, because the currents neutralise each other's influence on the electro-magnet. Hence from one battery and with one key we produce precisely the same effect as Gintl produced with his double key and his two batteries.

FIG. 3.



It will be thought by some that, by dividing the current between two circuits, as is shown in Fig. 3, half the current goes through the one wire and half through the other; hence that the strength of the currents received at B is reduced one half. But it is not so; for, while we have given a second path to the current, we have reduced the total resistance of the circuit very nearly one-half, and therefore we have almost doubled the strength of the main current: hence a current of very nearly the same strength arrives at B, whether the resistance coils, R, be introduced or not. It would be of precisely the same strength if we reduced the resistance of the battery one-half, for then we should reduce the total resistance of the circuit exactly one-half, and, consequently, exactly double the strength of the main current. Hence, whether there be a derived circuit or not at A, the currents which arrive at B are practically of similar strength.

FIG. 4.



The method of connecting up two stations worked on this plan is shown in Fig. 4. In describing Gintl's plan, I assumed, for the sake of simplicity, its application to an ordinary simple Morse receiver, though in point of fact the system was applied to a relay. In all the earlier Morse recording instruments relays were used because instruments could not be constructed sufficiently delicate to be worked by the line current direct. It was necessary to bring into play, by means of the relay, powerful local currents to impress the paper of the Morse receiver with its embossed characters. But with the introduction of ink-writers the necessity for the relay has been much reduced, since the work required to be done by the line current is very small; and there are now probably more Morse circuits worked without than with the relay. I will now, however, introduce the relay, because it was originally used by Messrs. Siemens and Frischen, and because it will help us in our subsequent examination and consideration of other plans. P is an ordinary polarised relay, whose tongue, *t*, vibrates between the two points, p and p', when actuated by currents in the proper direction. Its normal position is against the insulated stop, p, against which it is held by magnetic attraction. The line current moves it against p'. When this tongue, which is in electrical connection with terminal 6, is in contact with p', which is in connection with terminal 5, it completes the local circuit, which, starting from the local battery, L, passes through the receiver (*m*), and thereby causes signals to be recorded. The relay is wound with two wires of equal length and resistance, and which, therefore, make the same number of convolutions around the iron core of the electro-magnet. The ends of the one wire are brought to the terminals 1 and 2, and the ends of the other wire to the terminals 3 and 4. The one wire is called the *line* wire, and the other the *compensating* wire. It is evident that if, while a current is traversing the line wire, a second current of exactly similar strength is flowing through the compensating wire in the opposite direction, the effect on the tongue of the relay must be *nothing*. The incoming line wire is attached to terminal 1, and the artificial or compensating resistance to the terminal 4. Wires from terminals 2 and 3 are connected together at *a*, and attached to the lever of the key (K), which, in its normal position, places both these wires to earth at A, through the back contact, *k'*. The other extremity of the line wire of course makes earth through the apparatus similarly connected up at the station, B. The other extremity of the compensating circuit makes earth at E. Resistance coils, which can be varied and adjusted at will, are inserted in this circuit at R. One pole of the battery (*b*) is connected to the front contact pieces (*k*) of the key, the other pole being to earth at E; so that when the key is depressed, and *k* and K brought into contact, a current flows. Let us assume this key depressed. A current flows; at (*a*) it divides: one portion proceeds, *viâ* 2, through the line wire of the relay, out at 1 to the line, thence to earth at B, tending to press the tongue of the relay at A against the stop, *p*. The other portion proceeds, *viâ* 3, through the compensating wire, out at 4, through the resistance coils, R, to earth at E, tending to move the tongue of the relay against the stop, *p'*, in fact, in the same direction as it is moved by the line currents received from B. Now it is evident that if these two currents be of exactly similar strength, they will in no way influence the tongue of the relay, since they tend to move it with equal forces in opposite directions. But if they be of unequal strength, then the tongue will be moved in the direction of the strongest current, and by a force equivalent to that produced by a current equal to the difference of the two currents. Let us at first insert in R resistance small compared with that of the line, then the current passing through the compensating circuit will considerably exceed in strength that passing through the line circuit, and every time the key, K, is depressed the relay will work, and cause signals to be recorded. By gradually increasing the resistance, R, the difference in strength between the two currents is diminished until at last a point is attained where their strength is equal, and where the tongue of the relay is unaffected by the movement of the key. The artificial resistance, R, is now equal to the resistance of the line circuit beyond the terminal 1. If the resistance of the coils, R, be made considerably greater than that of the line, then the line current will considerably exceed in strength the compensating current; but inasmuch as the outgoing line current tends to press the tongue with greater force against the insulated stop, *p*, it causes no marks to be made when the key is depressed. Hence it is better to adjust this apparatus when connected up, as shown in Fig. 4, by working up from low resistance in R until complete compensation is obtained, for if we work in the reverse direction false security may be engendered. The line currents which are received at A enter at terminal 1, pass through the line wire of the relay, and out at 2, to earth through the back contact, *k'*, of the key, moving the tongue against the stop, *p'*, and recording signals in the usual way. Now, it is evident that when A works to B alone, A's relay remains unaffected if the proper adjustments be made, while B's relay causes the instrument at that station to record its signals. When, under similar circumstances, B works to A alone, B's relay remains unaffected, and A's receiver registers its marks by the action of B's line current upon the relay. But when A works to B at the same time that B works to A, what happens? The outgoing line current from each station is reduced in strength by an amount equal to the difference of the two line currents—viz., that coming in and that going out—at that station; the compensating current at each station preponderates by an amount equivalent to this difference, and this difference is equal to the strength of the incoming line current alone. Hence marks continue to be recorded with the same force and regularity when the stations work to each other simultaneously as when they work to each other separately and independently. Thus, as in Gintl's plan, while A is sending messages to B, B can also send messages to A upon the same wire, and at the same time.

I have shown the currents from each station to be opposed to each other, but it is very evident that the same effect precisely would occur if the currents acted in the same direction; only in this case the connections would be altered, the outgoing line current at each station would tend to move the tongue of the relay to *p'* instead of to *p*, and of course the compensating current would tend to move it in the reverse way. The mode of adjusting the compensating resistance-coils would also require reversal, greater resistance than that of the line being inserted first, which should be gradually reduced until neutralisation is obtained.

Now which of the defects of the previous method are removed or lessened in this plan?

1. The current is not broken during the depression of the key, for if the lever of the key at A is raised from the back contact, *k'*, the current received from B, which, after passing from 1 to 2, and thence to *a*, instead of going direct to earth through *k'*, proceeds to 3, through the compensating wire to 4, and thence through the artificial resistance to earth. This continues the effect of the line current upon the tongue of the relay, for, though the resistance to the line current is twice as great, and the current itself consequently reduced one-half, it passes through both wires of the relay in the proper direction to move the tongue towards *p'*, and therefore its influence is duplicated on the tongue, which leaves its total influence, and, consequently, its power of recording, the same as before. But what is its effect on B? The line current is suddenly reduced, the compensating current preponderates, hence the current received from A is anticipated, and marks are more firm and prolonged. This, however, only applies to the case when line currents are employed in opposition. When currents flow in the same direction from A and B, the compensating current has the opposite effect. The defect is, however, only partially remedied, for the current is still subject to great fluctuations due to the effect of the increased resistance upon the static induction of the line, which remains to be explained, and which is considerably increased if there be any underground or submarine wires in the circuit.

2. There being but one battery, any variation in its action is innocuous, for it effects both currents equally.

3. There still, however, remains the variation in the resistance of the line circuit, as compared with the compensating circuit. The latter circuit is constant, and subject to little change beyond the trifling one due to changes of temperature, but the former circuit is subject to all the changes due to the vicissitudes of the weather, to the effect of

those earth currents that are always more or less present in wires, and to the changes of temperature due to diurnal and climatic causes. Hence, the resistance of the line wire is constantly changing.

ON RAYS OF ELECTRICITY,
AND THE
LAWS OF THEIR SPREADING AND REFLECTION IN CONDUCTING PLATES.*

By Professor SCHWEDOFF, of Odessa.

WITH the view, not of adding one more to the many hypotheses which have been framed as to the nature of electricity, but of breaking down, if possible, some of the barriers which have hitherto existed between the region of electrical phenomena and those of light and sound, and of unifying our theories of all these phenomena on a basis of the same principle, I sought, experimentally, to answer the question whether there is an essential difference between the propagation of electrical currents in conductors, and that of light rays in transparent media; and if so, what is the nature of it? I have convinced myself that there is a mode of view by which we may bring electrical and light phenomena under the same principle.

To avoid misunderstanding, I must first clearly define the terms I use. An electrical pole is the point at which free quantities of electricity are present. Electrical current is the phenomenon, in which two electrical quantities (*Massen*), equal and of opposite name, flow through the same cross-section of a body in opposite directions with equal velocity. The direction of the positive electricity is the direction of the current. A straight line down from a pole to any point of the body I name a ray of electricity (*Electricitätsstrahl*). I must remark that I do not here attach any physical meaning to the word, but use it to express "the direction in which the electrical quantities are attracted to the pole or repelled from it."

According to the prevailing view, rays of electricity spread from a pole in all possible directions, and go through all bodies undisturbed. This would constitute a difference between electric rays and light rays; the latter of which, as is known, suffer certain changes of direction from the bodies on which they fall. Perhaps, however, the difference is only apparent, and the object of the following is to determine this question.

I. *Passage of rays in an infinite plane.*—Imagine a very thin, transparent, infinite plate of glass covered on both surfaces with amalgam; also a luminous point within it. The light rays coming from this point cannot pass out of the plate, but must spread in its plane. At distances r, R, from the light point, take two points, a, A, and describe, about the light point, with the radii, r, R, two cylindrical surfaces, whose common axis, h, is equal to the thickness of the plate, and whose bases coincide with the surfaces of the plate. Further, let i, J, denote the respective intensity of the rays at the points a, A, *i.e.*, the quantity of rays which fall normally on the unit of surface. The quantities of rays which fall on the entire cylindrical surfaces are respectively $2\pi rhi$ and 2πRHJ. These quantities must be equal, as all rays which have gone through the smaller cylindrical surface afterwards fall on the greater. We have thus—

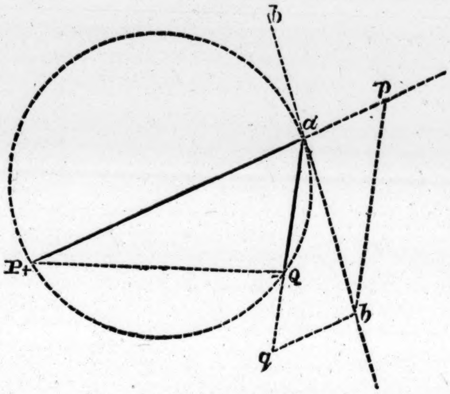
$$2\pi rhi = 2\pi \mathrm{RHJ}, \text{ or } \frac{\mathrm{J}}{i} = \frac{r}{\mathrm{R}},$$

that is, the intensity of rays which spread in the direction of a plane is inversely proportional to the distances from the point of light.

Applying this principle to the action of an electrical pole in a conducting infinite plate, insulated on both sides, we may draw an inference from it, which may easily be tested by experiment.

Let P and Q (Fig. 5), be two points in the plate, to which the positive and negative poles of a galvanic circuit are respectively connected, and a another point of the plate. On the $+e$ (positive electricity) of this point two forces, p and q, act in the directions, Pa and aQ, which forces are inversely proportional to the distances of the point, a, from the poles, so that—

FIG. 5.



$$\frac{q}{p} = \frac{\mathrm{P}a}{\mathrm{Q}a}.$$

To determine the direction of the resulting force, we must, with the prolongation of the rays, construct a parallelogram whose sides are proportional to the forces p and q. The diagonal, $a\ b$, shows the direction in which the positive electricity moves, under action of the two poles. Now it can be easily proved that this diagonal coincides with the tangent (drawn at the point, a,) to the circle which passes through this point and the two poles. Further, the $-e$ of the point, a, acted on by the two poles, moves in the direction, $a\ b'$, which is also tangential to the circle. Thus we have the law:—If with two points of a conducting infinite plate two electrodes are connected, the current branches in such a way that at any other point of the plate its direction corresponds to the tangent drawn at this point to the circle, passing through this point and the poles. This is the well known law of current division in an infinite plate, established by Kirchhoff. He grounded it, however, on quite different principles, which have nothing in common with phenomena of light.

II. *Reflection of electric rays from a boundary line.*—Conceive a transparent glass plate of limited size, and having both surfaces and edges coated with amalgam. Suppose a light point within the plate; the rays coming from it will not pass beyond the plate, but will be reflected from the amalgam. Consider, next, a conducting limited plate, surrounded with air. Within this plate suppose an electrical pole. If the rays proceeding from it follow the same laws as light rays, some of them will be reflected from the boundary, and then take a direction as if they came from a point corresponding to the catoptric image of the pole. Hence, a point, A, of the plate will be under the action of two rays, having the directions, p A, p' A, and whose intensities may be denoted by J J′ respectively. These intensities are inversely proportional to the lengths p A and p' A, so that—

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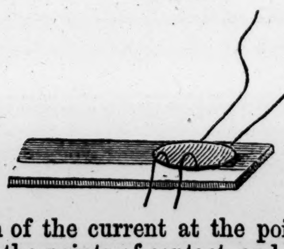
* Abstract of paper in "Poggendorff's Annalen."

$$\frac{J}{J'} = \frac{p'A}{pA}.$$

Hence the principle:—Where there is an electric pole in a conducting insulated plane limited by a straight line, we may reduce this case to that of an infinite plate. We have only to imagine a second point, p', outside of the plate, and corresponding to the image of the pole. To estimate the branching of a current in this case, let such a plate be bounded on one side, and at two points, P and Q, in the plate let positive and negative poles of a battery be respectively connected. The point, P, being at the edge, the reflection-image, P′, almost coincides with it. The image of the point, Q, is at Q′. On a point, a, in the plate, four poles thus act PP′ QQ′. The result on the $+e$ of the point, a, may be thus determined; Through a draw rays P a p, a Q q, a Q′ q', in the directions in which $+e$ of the point, a, tends to move under action of the four poles. From these rays mark off the lengths, $a f_0$, $f_0 f$, $a f_1$, $a f_2$, inversely proportional to the distances, a P, a P′, a Q, a Q′. These lengths represent the strength and direction of the forces from the four poles on $+e$ of a. Draw $f_2 s$ equal and parallel with $a f'$, and s F equal and parallel with $a f$. Then the line, a F, shows the strength and direction of the resultant force. This direction must also be that of the current as $-e$, under action of the same poles, moves in the opposite direction. And in the same way may the current-direction at any point of the plate be determined.

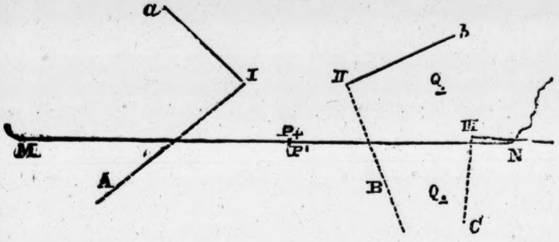
To test these results by experiment, I connected two points in a tin-foil plate with the electrodes from a battery, and pressed the ends of the wires of a multiplier in such positions in the plate that the multiplier showed no current. The wire ends being 5 m.m. apart, the line passing through the points of contact showed the direction without current, and the line at right angles to this the direction of the current at the point on the plate, between the points of contact, and equidistant from them. The sensibility of the multiplier was so great that a steel and copper thermo-element, merely warmed by the hand, produced in it a deflection of 50°. The wire ends were attached with shellac to a strip of glass, the extreme points pressing on its edge, as in Fig. 6. [Some further details of apparatus are given].

Fig. 6.



An example of the experiment may be studied in connexion with Fig. 7, in which M N is the border of the plate, P the position of the positive pole, Q that of the negative, of the battery. I., II., III. are the points at which the current-direction was to be determined. I.a, II.b, III.c, are the directions corresponding to the resultant forces, constructed as explained above. I.A, II.B, III.C, are lines drawn at right angles to these, and which show the theoretical directions in which there is no current. When the edge of the glass strip was placed in the direction of one of these last-mentioned lines, so that the numbered point lay between the wire ends, x y, no current appeared. On merely moving the edge of the strip 1° from the theoretical direction, there was a distinct deflection of the needle.

Fig. 7.



[Professor Schwedoff further investigates the case in which electric rays are twice reflected, as where there are two limiting edges meeting at an angle. The general principle of procedure is the same as above, and theory was in this case also verified by experiment. "In all such experiments it should not be forgotten that, as every plate has not one only but several edges, and the electric rays are reflected from each, there are a great number of active points, and the problem is somewhat complicated. If, however, the plate is pretty large, we may arrange that the position of the poles and the points to be examined should be so near to one or to two edges, and so far from the rest, that the action of the reflection poles for the latter may be neglected. One may satisfy one's self on this point as follows:—Determine, by the multiplier, the direction of current at a point, A, in the plate. Cut off a piece, a b, of the plate, in the neighbourhood of the edge, B; if the direction at a remains the same, the reflection-image of the edge, B, is without influence on the point, A."]

I will here sum up the results obtained by this investigation:—

1. The intensity of action of rays proceeding from an electrical pole in a very thin insulated conducting plate is inversely proportional to the length of the rays.

2. If the rays fall on a straight edge of the plate, they are reflected; the angle of reflection being equal to that of incidence.

3. If the once reflected rays meet another edge, they are again reflected according to the same rule.

4. The intensity of the rays which have been once or oftener reflected can be measured by the same units as the intensity of rays which have suffered no reflection. In reflection there is no sensible loss of intensity.

5. The reflection-image of a positive pole acts like a positive pole. The sign of the ray is not altered through reflection.

I refrain from speculating on the analogy between light and electricity till I have observed how electrical rays behave when reflected from curved surfaces.

ON A METHOD OF MEASURING INDUCED CURRENTS.

By F. H. BIGELOW.

If a Wheatstone's bridge be formed, in which the secondary coil of the inductorium is the resistance, R_1, to be measured, the relation between the resistances will be expressed by the proportion—

$$R_1 : R_2 = R_3 : R_4,$$

where R_3 and R_4 are in a fixed ratio. By passing a current from an independent battery through the primary coil, the strength of the current in R_2 will be increased or diminished on the breaking or making of the inducing current. Therefore, to preserve equilibrium in the bridge, R_1 must be changed, and we shall have—

$$R_1 \pm C : R_2 \pm x = R_3 : R_4,$$

in which x is a resistance equivalent to the effect of the induced current. Let $R_1 \pm C$ be found by trial such that the addition or subtraction of the induced current will produce equilibrium in the bridge,—that is, will be such as to bring the deflection of the galvanometer to the zero of the scale. We shall then have the strength of the induced currents expressed as resistances. One advantage of this method is this—that the readings are always reduced to the same point, the zero of the scale. This method, also, has a wider range than that of merely taking the swing of the galvanometer-needle; for currents which would throw the spot of light in a reflecting galvanometer off the scale can be readily kept on the scale in this method by merely altering the ratio of R_3 to R_4 in the Wheatstone's bridge. Since the shunting of induced currents is accompanied with difficulties, this method is especially advantageous. When the bridge was set up so that the smallest variation in the resistance of the branch containing the inductorium gave the greatest variation in the current going through the galvanometer, namely when—

$$\frac{dS_0}{dR_3} = 0,$$

S_0 being the current through the galvanometer, and the resulting value of R_3 being—

$$R_3 = \sqrt{\frac{GR_1(2B + R_1)}{G + 2R_1}},$$

in which G is the resistance of the galvanometer, B that of the circuit exterior to the Wheatstone's bridge, it was found that the induced currents could be measured to 100,000th of an ohm.

The following table contains a comparison of the induced currents produced by making and breaking the circuit. The first two columns contain the variation in ohms of the variable resistance of the bridge; the third and fourth columns give the strength of the induced currents on making and breaking, expressed in ohms.

Change in the Resistance on Breaking.	Change in the Resistance on Making.	Strength of Induced Current on Breaking.	Strength of Induced Current on Making.
650	600	0·00325	0·00300
700	680	0·00350	0·00340
720	720	0·00360	0·00360
720	750	0·00360	0·00375
700	700	0·00350	0·00350
850	850	0·00425	0·00425

Care should be taken to send the induced currents to be compared in the same direction, by means of a pole-changer. It will be seen, from the above Table, that the equality of the currents on making and breaking can readily be proved by this method.

ELECTRICITY AT ST. PAUL'S.

In the heart of the City of London, amidst the busiest of the busy haunts of men, stands the noble Cathedral of St. Paul. Pride in the structure is a necessary point in the dogma of the London sightseer, and right well placed is the admiration if beauty of outline or detail and historic wealth tell for aught. As the monument of a Wren, or the tomb of England's glorious heroes, apart from its higher worth as the central church of a great religion, the loss of our Cathedral would be a national calamity. Aye, even as an artistic lounge, for the many hundreds who daily dine with Duke Humphrey in its noble precincts, would its loss be felt. Seriously, we think there is not one, be he Englishman or foreigner, but would deeply lament any accident to our Metropolitan Church.

Yet how imminent its destruction has been we may never know. From the time when the present structure reared its golden crown in the murky atmosphere until nearly now, we may never know the greatness of the probability that London's church should have, in an instant, become an irreparable ruin, that the gifts generously intended for the restoration in progress should have formed a portion of the fund for the re-building. Many a less important and less exposed building has been crumbled to dust or reduced to ashes by the lightning flash; yet the temerity with which we have exposed our chief church to utter ruin is unparalleled—not to use a stronger term. And as much as former neglect is to be deplored, so is the thoughtfulness of the present authorities to be commended. Let us for one moment regard St. Paul's as it appeared not long since, unprotected. Primarily the building is far more lofty than any around it, and further it stands upon a hill (Ludgate Hill). At its summit, on the exterior, there is a mass of metal weighing tons—the cross, scrolls, and ball. This was found to be electrically insulated. It should, of course, have been in excellent communication with earth, the very reverse of insulation. Beneath these, and immediately above the great leaden dome, is a gallery of massive ironwork; both dome and gallery were electrically insulated. Still lower are the immense leaden surfaces of the aisle-roofs,—in fact, a metal cloud. And so well insulated were these immense sheets of metal that a powerful battery failed to give, upon a delicate galvanometer, a higher deflection of the needle than 2 degrees, and this upon a very wet day: 20 degrees would have been sufficiently indicative of fault in the connection with earth, and 90 degrees would indicate perfect earth. That is, the lightning discharge should have found no resistance in its passage to the earth, whereas the resistance opposed to its course was nearly infinitely great—as utter imperfection opposed to the requirement of perfection as practice could well give.

Inside the building we had to tempt the lightning, the iron stanchions of the scrolls and ball, and around the Whispering Gallery the immense iron gas-mains which supply the ring of jets immediately beneath the gallery. The sections of these mains are insulated from each other by the packing of the joints, and so are the successive sections descending the main-shafts to the bottom of the building.

The building has, we must in fairness admit, been supposed to be well protected by a series of conductors. But the supposition is inclusive of another, and the latter is that lightning will kindly select its passage across 1 to 6 feet of air, to the other portion of an interrupted conductor. About a hundred and twenty years ago thick iron rods or bars were supplied to the building by a Committee appointed by the Royal Society, and when they were put up doubtless the building was efficiently protected. But to rust is a property of iron, and a large amount of rust can accumulate in a hundred or so years; consequently these stanchions were found to be bedded, where connected to the roof, in large quantities of oxide; and during the passage of a powerful lightning discharge, experiments show that this oxide or rust would have exerted considerable explosive force. In many cases where the stanchions had been left, by the old Committee, connected to the iron hoods of the rain-pipes, stone hoods have been substituted, leaving the electric discharge to pierce some 6 or 9 inches of tolerably dry granite.

This was the electrical condition of St. Paul's in 1872. Yet, strange to say, in that year St. Paul's was stated to be, by the Committee on Lightning Conductors, a model that should be followed in all buildings. It must be supposed that the Committee did not see for themselves, or else had an overweening confidence in the good conduct of the electric fluid, for it is well known that lofty structures in much better connection with earth have been struck by lightning.

The authorities, however, did not appear to be satisfied with the electrical state of the building, for upon the report of Mr. John Faulkner, Associate of the Society of Telegraph Engineers, of Manchester, they commissioned him to prepare a plan for the fitting of the cathedral with an efficient system of conductors. The plan submitted was approved, and the fitting is now completed. In metallic connection with cross and ball and scrolls are eight copper conductors, each being a ½-inch strand of copper wires. The octagonal strand has been adopted as giving most metal in the least space. These eight conductors then pass to the metallic railing of the Golden Gallery, with which they are in metallic connection. Thence they are carried down to the dome, to the metallic surface of which they are again connected at several portions of their length. Then down the rain-falls, over the leaden roofs of the aisles, in the angles formed by the aisles themselves, again down the rain-falls to the sewers. Further, the choir and nave roofs are connected together by a saddle or conductor stretching over them both, and joined to the conductors proceeding from the summit of the west towers. Even this did not satisfy the zealous care of Mr. Faulkner, who tested, sheet by sheet, the electrical condition of the leads, connecting the worse insulated sheets by copper bands to the better conducting surfaces. Thus the dome, aisle-roofs, and ball and cross, and the two west towers, form one immense metallic conductor, and the danger arising from interior gas-piping is removed; for Coulomb and Faraday have proved beyond doubt that electricity accumulates upon the surface only of bodies. In the sewers, which always afford a moist earth connection, the copper strands are riveted to copper plates, and these again are pegged into the earth. By this means as good an earth connection is obtained at the top of the cross, at the very summit of the Cathedral, as is found in the sewers at its base.

The method of practical testing adopted by Mr. Faulkner is the following:—At any point to be tested a wire is carried to a neighbouring gas-pipe for a second earth: this wire is attached to an ordinary vertical galvanometer, and this again to a couple of Leclanché cells, the other pole of the two-celled battery carrying a wire which is touched to the portion of metal roofing to be tested. The galvanometer is first deflected with only the wire in circuit, and the deflection is noted. Then the earth-connections are made, and the deflection again noted. Unless the deflections are identical within a limit of 1 or 2 degrees, Mr. Faulkner proceeds to re-connect by bands that portion under test to some other portion giving perfect earth. In this way nearly every square yard of the leads has been tested.

Necessarily great trust has been reposed in Mr. Faulkner, but the authorities have been well acquainted with his work and the number of large churches fitted with his improved conductor, of the strand before mentioned; while Mr. Faulkner himself has the satisfaction of knowing that he has preserved a great historical monument from danger and the nation from the probable calamity of the destruction of our metropolitan Cathedral of St. Paul by lightning.

MATHEMATICS
FOR
NON-MATHEMATICIANS.

By WILLIAM PAGET HIGGS, LL.D.

(Continued from p. 200.)

DIVISION I.—THE ALGEBRA OF CONSTANT QUANTITIES.

Negative Exponents, Roots, and the Use of Exponents as Logarithms.

WE have learnt that algebraists agree to write, for the multiplication indicated by xx or $xxxx$, the expression x^2 or x^4. And now let us find out for ourselves the effect, upon the exponents, of the addition, subtraction, multiplication, and division of the quantities x^2, x^4.

$xx+xxxx$ and x^2+x^4, or $xx-xxxx$ and x^2-x^4, is the simplest manner in which we can express the addition and subtraction of these quantities.

But when we multiply x^2 by x^4 the product shows us a wonderful property pertaining to the exponents.[*] Thus—

$$xx\,.\,xxxx=xxxxxx, \text{ or } x^6;$$

$$\text{Or } x^2\times x^4=x^6.$$

That is, *multiplying the quantities* x^2 *and* x^4 *together is equivalent to adding their indices or exponents;* or $x^2\times x^4=x^{2+4}=x^6$.

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[*] INDEX is another term for exponent; plural INDICES.

If we seek to divide* x^4 by x^2, we shall see that *xxxx* contains *xx* the number of times represented by *xx;* that is *xx* must be multiplied by *xx* to produce *xx . xx* or *xxxx;* and this is but saying that x^4 divided by x^2, or $x^4 \div x^2$, or $\frac{x^4}{x^2} = x^2$. We learn, then, *that dividing the quantity* x^4 *by* x^2 *is equivalent to the subtraction of the index* $(^2)$ *of the divisor from the index* $(^4)$ *of the dividend*; or that—

$$\frac{x^4}{x^2} = x^{4-2} = x^2.$$

Now this subtraction of indices naturally includes the extension of the idea to *negative indices.* For if we reverse the position of the quantities given above we obtain a result with a negative index:—

$$\frac{x^2}{x^4} = x^{2-4} = x^{-2}.$$

And again, by extending our view of the meaning of the term index or exponent, we may arrive at some remarkable, and, as we shall presently perceive, very useful, results. x and x^1 we know to be identical in value, so that—

$$\frac{x^1}{x^1} = \frac{x}{x}.$$

But—

$$\frac{x^1}{x^1} = x^{1-1} = x^0.$$

And—

$$\frac{x}{x} = 1.$$

Whence—

$$x^0 = 1,$$

which expression, if the reader will presently return to it, he will perceive to be the reason or proof that the logarithm of unity to any base is zero; and since $a = a^1$ the logarithm of the base of any system is unity.

Following our reasoning, we may say—

$$\frac{x^0}{x^1} = x^{0-1} = x^{-1};$$

but substituting the value obtained above for x^0,—viz. 1,—we have—

$$\frac{x^0}{x^1} = \frac{1}{x^1}, \text{ whence we learn } x^{-1} = \frac{1}{x^1} \text{ or } \frac{1}{x}.$$

Unity divided by any quantity is the reciprocal of that quantity. $\frac{1}{x}$ is the reciprocal of x; $\frac{1}{2}$ is the reciprocal of 2. So that *a quantity raised to a negative power is equal to the reciprocal of the positive power of that quantity;* or $x^{-n} = \frac{1}{x^n}$, whatever number n may stand for. By which we may arrive at the value of a negative power.

As we can have integral or whole positive and negative exponents, so an extension of reasoning will comprehend fractional exponents. Fractional exponents are employed to indicate *roots.*

A *root* is the quantity that produces a *power.* As the second power or square of 2 is 4, so the square root of 4 is 2. As the third power or cube of 2 is 8, so the cube root of 8 is 2.

The radical sign $\sqrt{}$ (a corruption of the letter *r*) is employed to indicate the lowest or square root of a quantity. And similarly $\sqrt[3]{}$ is employed to indicate the cube root, $\sqrt{}$ the fourth root, &c. Thus—

$$\sqrt{4} \text{ or } \sqrt[2]{4} = 2.$$

$$\sqrt[3]{8} = 2.$$

$$\sqrt[4]{16} = 2.$$

Or, substituting for the radical signs fractional exponents, we have—

$$\sqrt{4} = 4^{\frac{1}{2}} = 2.$$

$$\sqrt[3]{8} = 8^{\frac{1}{3}} = 2.$$

$$\sqrt[4]{16} = 16^{\frac{1}{4}} = 2.$$

Now it is clear that we may read $\frac{1}{2}$ as "the second root of the first power," or as "the (first) root of the second power," for the result is the same, viz., 2. And that—

$$x^{\frac{n}{n}} = x,$$

which is but raising a quantity to a power to reduce it again to its radical or root value.

From our reasoning we may deduce the following *resumé:*—

That with powers of the same quantity—

To MULTIPLY, *add* the indicos.

To DIVIDE, *subtract* the index of divisor from index of dividend.

To find a POWER, *multiply* the index of the quantity by 2 or 3 or (n) the number of the required power.

To find a ROOT, we *divide* the index of the quantity by 2 or 3 or (n) the number of the required root.

Now since every quantity (a or x) may be written under the form a^1 or x^1, these rules will hold good for all quantities, and admit of the general expressions—

$$x^1 \times x^1 = x^{1+1} = x^2.$$

$$\frac{x^1}{x^1} = x^{1-1} = x^0; \ \frac{x}{x} = 1; \text{ and } x^0 = 1.$$

$x^2 = x^{1 \times 2}$ (or the index 1 multiplied by 2).

$\sqrt[2]{x} = x^{\frac{1}{2}}$. (or the index 1 divided by 2).

But, says the reader, what is the practical benefit of all this? We reply, that by a very simple application of these principles are our sailors enabled more easily to navigate our ships, the naval architects to design them, the engineer to build our bridges, the astronomer to tell us of the movement of other worlds. The application is Logarithms, without which our laboratories, studies, and workshops would indeed be badly off.

LOGARITHMS.

The term *logarithm* is derived from λογων αριθμος (*logon arithmos*) or the *number of ratios.* Thus, between 1 and 10 there is *one* ratio; between 1 and 100, two ratios; and between 1 and 1000, three ratios of 1 to 10. The definition has been given that—"The logarithm of a number (to a given base) is the index of the power to which the base must be raised to give the number."

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* Division is represented algebraically and arithmetically by the sign $\div$, or more generally by writing the quantity to be divided above a short line, and the divisor below the line, as in fractions. Thus, 1 divided by 2 may be written $1 \div 2$, or $\frac{1}{2}$; that is, one-half. Similarly, a divided by b is written $\frac{a}{b}$ or $a \div b$. The result of the division is termed the quotient.

Thus if $n=b^l$, l is the logarithm of n the given number to the base b. And if $n=100$, and b, the base, be 10, then $l=2$; for—

$$100=10^2.$$

If $n=1000$, then $l=3$; for—

$$1000=10^3; \text{ and so on.}$$

In the following table let n = the number for which we wish to find the logarithm; b, the base; and l, the index or logarithm, and we have—

$$\begin{array}{rcl} n & & b\ \ l \\ 1 & = & 10^{0\,*} \\ 10 & = & 10^{1} \\ 100 & = & 10 \\ 1000 & = & 10^{3} \end{array}$$

That is, the logarithm of 1 is 0,
10 is 1,
100 is 2,
1000 is 3, and so on.

Consequently, for all numbers between 1 and 10 the logarithm or index is a fraction: between 10 and 100, 1 plus a fraction; between 100 and 1000, 2 plus a fraction. These fractions have been calculated, and are to be found in tables,[†] of which we shall presently give an example.

The logarithm of a number, n, to a base, b, is usually written $\log._b n$; and so if $n=b^l$,—

$$l = \log._b n.$$

If the base b were 2, and the number 8, the logarithm would be 3, and the expression would become—

$$3=\log._2 8.$$

But, as our notation is founded upon the decimal system, the base of the common system of logarithms is 10, and this being understood the letter b, is omitted. Thus the logarithm of 10 is written $\log.\ 10=1$.

Soundings for a Cable between the United States and Japan.—The United States steamship *Tuscarora*, Commander George E. Belknap, now at San Francisco is being fitted to make deep-sea soundings in the Pacific for a cable route between the United States and Japan, this authority having been granted by the last Congress. The sounding apparatus made for the *Juniata* has been sent to San Francisco, together with 15 miles of carbolised sounding line: 30 miles of steel wire and one of Thomson's sounding apparatus have also been ordered. The vessel will be ready to sail early this month, and will proceed toward Puget Sound, thence to the Aleutian Islands, and stop at Yokohama.

Progress of Plated Ware Manufactures.—By many the plated goods are preferred, not only on account of the difference in cost, but because the designs and appearance of the goods are nearly identical with the solid ware. The Meriden Britannia Company confine their attention mainly to the manufacture of nickel silver and white metal silver-plated goods. The Company was established in 1852, at West Meriden, Conn., where they now occupy 5 acres of ground, and have eight factories, the largest of which is 700 feet long, presenting an imposing appearance. The capital invested is £400,000, and the capacity of the works about £800,000 yearly. The Company employ 700 men.

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[*] We see now the meaning of $a^0=1$, or that the logarithm of unity to any base is zero (^{0}).

[†] Galbraith and Haughton's should be obtained by the student.

Students' Column.

First Principles of Galvanometers.

By ROBERT SABINE, C.E.

ROMAGNESI[*] observed (in 1802) that the passage of an electric current through a wire in the neighbourhood of a suspended magnet-needle caused the needle to be deflected from its position of magnetic equilibrium. Oersted[†] observed (in 1820) that a wire through which a galvanic current was flowing had the tendency of turning a freely-suspended magnet-needle into a position at right angles to the plane passing through the wire and the middle of the needle.

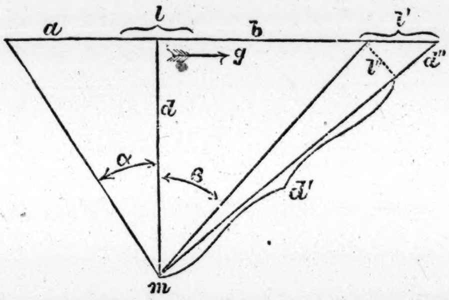
Ampère[‡] observed (in 1821) that *when a positive current moves in a wire from south to north, over and parallel to a magnetic needle, the latter is deflected, with a tendency to place itself at right angles to the wire, the north pole pointing westward.*

Subsequently, Biot and Savart[§] occupied themselves with the task of establishing the relation between the force exerted in the deflection of the needle and the distance of the galvanic current moving in a straight conductor of infinite length, and found that:—

"*The total effect of an infinitely long and straight conductor upon any magnetic element is in inverse proportion to the distance of the element from the nearest point of the wire.*"

Imagine a current whose strength is g, moving in the conductor, $a\,b$ (Fig. 8), and a magnetic particle of the magnetic intensity, m, at a perpendicular distance, d, from it. The unit length, l, of $a\,b$ acts upon m, with the force—

FIG. 8.



$$= \frac{m\,g\,l}{d^2}$$

that is to say, it attracts or repels it with a force directly proportional to the magnetic intensity of the particle, to the length of the very short conductor acting upon it, and to the strength of the current, but inversely to the square of the distance.

Suppose l is placed at l' so as to act at an angle β, we must now resolve l' into the two forces l'' and d'', the latter of which is powerless upon m. The component, l'', at the distance, d_1, acts upon m with the force—

$$\delta\, I = \frac{m\,g\,l''}{d_1{}^2}$$

and as $l'' = \delta\,\beta.\,d_1$

$$\delta\, I = \frac{m\,g\,d_1}{d_1{}^2}.\ \delta\,\beta = \frac{m\,g}{d_1}.\ \delta\,\beta.$$

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[*] "Manuel du Galvanisme," by J. Izarn. Paris, 1804.

[†] Gilbert's "Annalen," 66, p. 295.

[‡] "Ann. de Chim. et de Phys.," vol. xv.

[§] "Experimental Physik," Von Biot. Translated by Fechner, 1829, vol iv., p. 158.

Further, since

$$\frac{d}{d_1} = \cos. \beta$$

$$d_1 = \frac{d}{\cos. \beta}$$

therefore we may write—

$$\delta I = \frac{m\, g \cos. \beta.}{d}. \delta \beta$$

which expresses the force of a length of the straight conductor subtended by the angle, $\delta \beta$, at an angle $\beta°$ with the perpendicular d.

This value integrated gives the total force between the angles and

$$I = \int_{a}^{\beta} \frac{m\, g \cos. \beta.}{d} \delta \beta.$$

$$= \frac{m\, g}{d} (\sin. \beta - \sin. a)$$

Therefore, if a and b are infinitely long, or $a = -90°$ and $\beta = 90°$

$$I = 2 \frac{m\, g}{d}$$

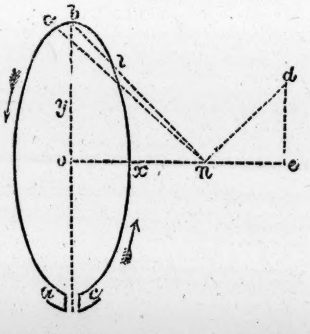
For each side of the vertical line the force being:—

$$\frac{m\, g}{d}$$

Therefore *the deflective force of a straight and infinitely long conductor upon a magnetic element is directly proportional to the intensity of the element and to the strength of the current, and inversely to the nearest distance.*

For the effect of a circular current upon a magnetic element, Weber has given a mathematical development, which is substantially as follows* :— Let $a\ b\ c$ represent a metallic ring in which a galvanic current of the strength, g, is circulating, as shown by the arrows (Fig. 9). Let the radius of the ring be y and its centre o. At the point n, in the axis of the ring, at the distance, x, from the centre, imagine the existence of a north-magnetic element whose intensity is m.

FIG. 9.



The current in any short length, δa, of the circular conductor tends to deflect the magnetic element, n, towards d, that is to say in a direction at right angles to the line, $b\ n$, joining the magnetic element and the current element. This deflective force, as we have seen by the above, is directly proportional to the intensity (m) of the magnetic element, to the length ($y\ \delta\ a$) of the very short conductor, and to the strength (g) of the current, but inversely to the square of the distance (l). Or, if ($n\ d$) represent this deflective force,—

$$(n\ d) = \frac{m\, g\, y\, \delta\, a}{l^2}$$

This force ($n\ d$) we can resolve into the two forces ($n\ e$), in the axis of the current, and ($d\ e$) at right angles to the axis; the former being the component which acts deflectively upon the needle.

Now the two triangles, $b\ o\ n$ and $n\ e\ d$, are obviously similar. Hence

$$(n\ e) : (n\ d) :: (b\ o) : l$$

or,

$$(n\ e) = \frac{(n\ d).\, y}{l}$$

The effective component ($n\, e$) exerted by the short conductor to produce the deflection is therefore—

$$(n\ e) = \delta\, \mathrm{I} = \frac{y}{l} \cdot \frac{m\, g\, y.\, \delta\, a}{l^2}$$

or, since $l = \sqrt{x^2 + y^2}$,

$$\delta\, \mathrm{I} = \frac{m\, g\, y.^2 \delta\, a}{(x^2 + y^2)^{\frac{3}{2}}}$$

and (putting 2π for $\delta\, a$) we get the resultant of the forces exerted by the whole ring upon the magnetic element to move it in the direction of the axis :—

$$\mathrm{I} = \frac{2\, \pi\, g\, m\, y^2}{(x^2 + y^2)^{\frac{3}{2}}}$$

which, translated into words, means that *a magnetic element in the axis of a circular current is attracted or repelled from the centre with a force which is directly proportional to the area of the circle, and inversely to third power of the distance of the element from the periphery.*

PAPERS FOR JUNIOR STUDENTS.

Signals and Signalling.

If we study the construction of the Morse key, it will be perceived that the two signals most easily transmitted by the key having the greatest difference from each other are a contact of very short duration and a contact of long duration. The short contact we know as a *dot;* the long contact as a *dash.* The key held down while we count "one" will produce a dot upon the receiving instrument; held down while we count "one, two, three," a dash.

Other intervals of contact might be suggested; they would, however, not only be difficult to remember, but the electrical condition of our telegraph lines would preclude their use. For instance, in telegraphing across the Atlantic, the signals suffer from the effects of induction and the inertia of the receiving instrument, with the result that they are lengthened or shortened.

A code of signals has been constructed by combining the dot and the dash, the shortest signals being used for those letters occurring most frequently. Thus e, the letter that occurs most often in the English language, is represented by a dot. The code in almost universal use is the Morse Code, which we give in alphabetical order :—

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* Poggendorff's Annalen, 55, p. 29.

THE MORSE CODE.

A - —
B — - - -
C — - — -
D — - -
E -
F - - — -
G — — -
H - - - -
I - -
J - — — —
K — - —
L - — - -
M — —
N — -
O — — —
P - — — -
Q — — - —
R - — -
S - - -
T —
U - - —
V - - - —
W - — —
X — - - —
Y — - — —
Z — — - -

The accented and compound letters (not often employed in practice) are—

Ä ä (æ) - — - —
é - - — - -
ö (œ) — — — -
ü (ue) - - — —

The signals for marks of punctuation, &c., are—

Full stop (i i i) - - - - - -
Colon (o s) — — — - - -
Semicolon (n n n) — - — - — -
Comma (a a a) - — - — - —
Note of interrogation (U D) - - — — - -
,, admiration (G W) — — - - — —
Hyphen (B A) — - - - - —
Apostrophe (W G) - — — — — -
Parenthesis (K K) — - — — - —
Inverted commas (R R) - — - - — -
Italics or underlined (L L) - — - - - - — - -

Bar of division, fractions — — — — — —
Call signal — - — - — - —
Understand message - - - — -
Correction or rub out - - - - - - - -
End of message - — - — - — -
Wait - — - - -
Begin another line - — - — - -
Cleared out and all right - — - - — - - — -

Figures are represented by the following signals:—

1 - — — — —
2 - - — — —
3 - - - — —
4 - - - - —
5 - - - - -
6 — - - - -
7 — — - - -
8 — — — - -
9 — — — — -
0 — — — — —

Each figure, it should be observed, is represented by five signals. Commencing with one dot and four dashes, five dots are reached, and then the signals are reversed for the four remaining digits and the cipher. In practice sometimes the signals for the figures are contracted, that is, a dot and a dash are sent for 1, two dots and a dash for 2, &c., a dash and 3 dots for 7, and a dash alone for 0.

The rules for combining the signals into letters and words are very simple, and are included in the—

Rules for Spacing.

1. The length of a dot being taken as unit,—
2. A dash is equal in length to three dots.
3. The space between the constituent signals of a letter is equal to one dot.
4. The space between the two letters of a word is equal to three dots.
5. The space between two consecutive words is equal to two dashes or six dots.

To aid students in committing the signals to memory, a mnemonical device has for some time been in use in the Government Schools. The letters are classed in the order of most frequent occurrence, thus:—

E	I	S	H	
-	- -	- - -	- - - -	
T	M	O	CH	
—	— —	— — —	— — — —	
A	W	J	U	V
- —	- — —	- — — —	- - —	- - - —
N	D	B	G	Z
— -	— - -	— - - -	— — -	— — - -
R	L	P	F	
- — -	- — - -	- — — -	- - — -	
K	C	Y	X	Q
— - —	— - — -	— - — —	— - - —	— — - —

This order may be more easily committed to memory by arranging the letters as initials in the following nonsensical sentences:—

E*arwigs* I*nfest* S*ummer* H*ouses.*
T*ea* M*akes* O*ne* CH*eerful.*
A W*et* J*acket's* U*ncomfortable* V*ery.*
N*o* D*ifficulty* B*affles* G*reat* Z*eal.*
R*emember* L*aw* P*reserves* F*reedom.*
K*indness* C*onciliates* Y*outh* *e*X*tremely* Q*uickly.*

The student should first learn these lines. Then observe that—

The first letter of the first line is a dot.
,, ,, second ,, dash.
,, ,, third ,, dot and dash.
,, ,, fourth ,, dash and dot.
,, ,, fifth ,, dot, dash, dot.
,, ,, sixth ,, dash, dot, dash.

And that the elements of the letters receive a regular increment agreeing with their place in the line. He should also remark that the opposite or reciprocal (*i.e.* where there is a dot in one there is a dash in the other letter) to—

A is N,
W ,, D,
J ,, B,
U ,, G,
R is K,
L ,, Y,
P ,, X,
F ,, Q.

By thus classing the symbols the student will not have so many independent facts to commit to memory, and there will be a certain association that will afford him considerable aid.

It will at once be perceived that messages can be transmitted by combinations of any two signals. Two men standing in elevated positions could communicate at a distance with one another if they had previously determined that a movement of the right hand should represent a dash, a movement of the left a dot. Communication could by this code be established between distant places by flashes of light, by sounds of long and short duration, or by two lights and two notes, or by movements upward and downward, or to the left and to the right, of a flag or a light. Presently we shall follow the application of the code in the single needle, bell, and the marine galvanometer and recorder instruments.

When the code has been committed to memory we will describe the method of transmitting a message.

Electrical Gas Lighting.—A novel device for lighting gas by electricity is made as follows:—A glass cup is immersed in liquid; and when the gas is turned on, it enters under the cup and lifts the same, thereby establishing connection with a battery which heats a platinum wire placed over the burner, and thus ignites the gas.

Proceedings of Societies.

GEOGRAPHICAL SOCIETY OF BERLIN.

At the last meeting of this Society, with Baron Richthofen in the chair, Dr. Neumayer spoke on methods of measuring the temperature of the water, at great depths in the sea, and of a new instrument which he has invented for that purpose. The discovery of the fact that an ordinary mercurial thermometer does not correctly measure temperatures when subject to high pressure, such as is found at greath depth, and that the errors of a single reading may react as much as 12° F., led to the improvement of surrounding the bulb with a larger one filled with alcohol, thus removing the thermometrical errors caused through the working of the instrument. By this instrument, however, the point in the scale to which the column of mercury reached at any required depth could not be ascertained. The methods devised for overcoming this difficulty were all directed towards introducing means for indicating the maximum and minimum points. Since none of these fully obtained the desired end, improvement must be sought for in obtaining some method of reading the thermometer while under water. Mr. W. Siemens made the first improvement in this direction, but the results obtained by his method are found to be unsatisfactory. The new instrument invented by Dr. Neumayer is based upon the plan of devising a self-registering thermometer. His first object was to obtain a light capable of doing photographic work, but not producing heat so as not to create errors. These conditions are fulfilled by the Geissler tubes, chiefly by those containing nitrogen. The instrument experimented with consists of a brass vessel containing—(1) two vertical thermometers, which protrude through the bottom of the vessel into an open compartment, free to the access of water; (2) a galvanic battery; (3) two Geissler tubes, running in front of, and near to, the thermometers; (4) two rolls of Talbot paper standing upright and immediately behind the thermometers, and made to revolve by clockwork. When the batteries are closed and the clockwork wound up, the luminous tubes cause the picture of the column of mercury, together with the lines marking the partition of the scale, to be reproduced on the photographic paper behind. When lowered into the sea the vessel is shut hermetically. The record of the temperature of the surrounding water at any instant, and therefore at any depth to which the vessel may be lowered, is distinctly read on the paper when the instrument is raised. A further improvement was made by adding an instrument for determining the direction of the current at various depths. It is constructed as follows:—on the top of the instrument a compass card, turning freely around its axis, is attached, and on the outside of the vessel a sort of wing, which will be directed by the current when the ship is slightly moving. The deviation of the wing from the north and south line of the card is shown by the same photographic means. Mr. Siemens recommended the use of chased copper instead of brass in constructing the vessel, on account of the greater resistance it offers to pressure. He also mentioned an improvement he believed he had made in the instrument invented by himself and his brother.

Gramme's Machine.—The *Quarterly Journal of Science* for July contains a valuable paper by William Crookes, F.R.S., entitled "Magneto-Electric Illumination." The illustrations convey a clear idea of the important improvements effected by M. Gramme in magneto-electric machines. The same journal also contains a paper by Mungo Ponton, F.R.S.E., on "Actinism and Magnetism."

Notices of Books.

A Treatise on the Strength of Bridges and Roofs, with Practical Applications and Examples for the Use of Engineers and Students. By Samuel H. Shreve, A.M., C.E. New York: Van Nostrand and Co. 1873.

Although there is only the collateral relation of Engineering Science between the subject of this work and that of the Journal, there is a common ground upon which we may judge of the merit of Mr. Shreve's work, the simple use of simple algebraic rules. The first chapter commences with short definitions of the terms truss, strains, chords, &c.; then the laws of the lever, the resolution of forces, and the equality of moments are given. The work throughout is characterised by the simplicity and practical nature of the necessary formulæ, and the engineer or the student will do well to possess himself of this admirable addition to American engineering literature.

Introduction to Chemical Physics. By Thomas Ruggles Pynchon, M.A., Scovill Professor of Chemistry and the Natural Sciences, Trinity College, Hartford. New Edition, revised and enlarged. New York: D. Van Nostrand. 1873.

Very hard indeed in the great and laudable race to produce the best scientific literature are we pressed by our American brethren. Far behind us years ago, now their minor text-books in Physical Science are equal to ours, if not, in many cases, produced at a greater expenditure of work. As an instance, we have Mr. Pynchon's text-book. This book is, whether for heat, light, or electricity, really wonderful in its elegant detail of experimental and theoretical science. It is what a primary text-book should be, simple condensation of facts with as simple statement of their correlation. Great aid is given to the student by the outline, at the end of the work, of a series of experiments, illustrative of the fundamental truths he has acquired, a plan we should like to see more often adopted.

Electrical Science in Foreign Journals.

(We intend to devote this column to a list of Electrical Memoirs published in Foreign Journals during the month. Those of importance will be either translated in full or given in abstract.)

Comptes Rendus Hebdomadaires des Séances de l'Academie des Sciences, Vol. lxxvi., No. 25.

New Researches on the Electric Flux.—By MM. P. and Arn. Thenard.—In this paper MM. Thenard describe the action of the induced electric flux upon the vapour of water, ammoniacal gas, nitrogen, and steam, gaseous phosphide of hydrogen, and its mixture with bicarbide of hydrogen alone, and with monohydrate of methylene. The paper is too lengthy for abstraction; it includes the detail of eighteen experiments. *En resumé*, it is stated—(1). That the vapour of water is not prejudicial to the production of the flux, and that the flux decomposes it into its constituent gases; (2). That the flux as well as determining the combination of nitrogen and hydrogen decomposes ammoniacal gas, but that, in both cases, without absorbent bodies, there is found in the gaseous mixture a small but sensible quantity of ammonia; (3). That nitrogen under the influence of the flux and the vapour of water disappears in order to give rise to an undetermined substance, which is termed provisionally nitrite of ammonia; (4). That the gaseous phosphide of hydrogen is also incompletely decomposed by the flux, and that the decomposition is accompanied by phenomena which prove the formation of liquid phosphide, subsequently of solid phosphide, finally of a body that is thought to be amorphous phosphorus; (5). That the flux acting on a mixture of gaseous phosphide of hydrogen and of bicarbide of hydrogen reproduces traces of phosphorated alkalies; (6). That under its influence the bicarbide of hydrogen alone is condensed into an odorant liquid, soluble in ether and insoluble in water; (7). That, on the contrary, the monohydrate of methylene is transformed in the presence of water into marsh-gas, pure hydrogen, an acid easily soluble in water, and a resinous substance different to the viscous bodies furnished by the bicarbide.

No. 26.

On Magnetism.—By M. J. M. Gaugain.—In a preceding note I have pointed out the modifications produced in the magnetic state of a horse-shoe magnet when an armature of soft iron is applied to its poles; and I said that in order to give a correct result it was sufficient to trace the curves of demagnetisation before and after the application of the armature. When we apply a soft iron armature against the polar faces of a horse-shoe magnet, the magnetisation caused by the induction currents are augmented throughout; at no part is there diminution. I believe it necessary to insist on this result, because it appears to me difficult to conciliate with the generally admitted idea of a condensation of magnetism in the neighbourhood of the contact surface; if the magnetism does accumulate near this surface as supposed, it should diminish at some other part, but, as I have stated, experiment proves that it is augmented. I think, then, that the idea of condensation must be abandoned. I have made the following observations:—(1). Even after the application of the armature, the current of demagnetisation which corresponds to the heel, that is to say, to the middle of the curve of the horse-shoe, is sometimes even greatly superior to the currents of demagnetisation which correspond to the extremities of the branches of the magnet; (2). When the armature itself presents the form of a horse-shoe, and is of the same section as the magnet, the currents of demagnetisation are nearly equal in the immediate neighbourhood of the surface of contact both with magnet and armature; (3). When the armature has no great length the magnetisation is nearly uniform throughout that length. When a bar of soft iron is applied to a point of the surface of a horse-shoe magnet, perpendicularly to that surface, we know that the magnetic intensity is diminished around the bar, and this diminution is generally explained as arising from magnetism attracted by the soft iron, and condensed near the contact surface of the magnet and the bar. This interpretation appears to me to be incompatible with the facts I have pointed out. In a former note I said that the magnetic intensity measured by my own method varied similarly to the magnetic intensity determined by other methods, and I have since established by experiment that the magnetic intensity measured by Coulomb's method of oscillations is proportional to the magnetic intensity measured by means of induction currents.

Les Mondes. Vol. xxxi., No. 11.

New Battery.—By M. Zaliwski.—I take two porous cups, one larger than the other; in the cup containing the carbon I pour nitric acid; in the other, sulphuric acid; and in the outer vessel containing the zinc I put a concentrated solution of sal-ammoniac.

Letter (extract) from Count Marschall on Theoretical and Practical Science in Austria. Electricity.—Dr. Streintz has communicated to the Imperial Academy of Vienna some results of his experiments on the modification in length and elasticity in a metallic wire by the galvanic current. He sought to ascertain whether the modification in length and elasticity arising from the heating effect of the galvanic current occurred with other sources of heat. He finds that the elasticity is affected alike by all sources of heat, but that the modification of the length offers important variations. A wire 53·5 m.m. long and 0·5 m.m. diameter, under the action of a difference of temperature of 37° C., suffered a change in length of 0·040 to 0·060 m.m., that is to say about 15 to 20 per cent of that effected by simple heating. The value of the extension is the same for wires in brass, copper, platinum, and soft steel. Three hard steel wires gave +0·009, +0·007, and −0·002. These values fall within the limits of errors of observations, and we may conclude that hard steel wire suffers no change under the action of the galvanic current.

Archives des Sciences Physiques et Naturelles. Vol. xlvi. No. 29.

Electrical Figures on Conductors.—By H. Schneebeli.—M. Schneebeli has investigated the conditions on which depend the dimensions of Kundt's electrical figures, which result from the adhesion of a fine insulating powder upon a metallic conductor from which a discharge has just issued. In his experiments the discharge of a Leyden jar took place between a horizontal metal plate, sprinkled with lycopodium powder (for the production of the electrical figures), and an electrode in the form of a knob, cone, or point surmounting it. The author has found that, *ceteris paribus*, the diameter of the figure increases with the distance of the electrode from the plate, but not in a constant ratio; the line which represents the ratios is not straight, but an undulating curve. Also the size of the figure augments with the quantity of electricity which produces it. When the electrode is composed of a certain number of points, a circular figure is formed beneath each of them. If a small disc of glass is interposed in the path of the discharge there is produced on the plate a space void of powder, and having exactly the shape of the disc. With electrodes of a conical form with an angle of 60° or of 30°, or in the shape of a tapering needle, M. Schneebeli ascertained that the electrical figure is as much larger as the angle at the summit of the cone is smaller. Lastly, the diameter of the figure is greater when the discharge is effected in a rarefied gas than at the ordinary pressure.

The Telegrapher. Vol. ix., No. 363.

Hick's New Repeater.—A very effective repeater or relay-sounder on the Bright's bell system.

Automatic Telegraphy.—A description of the so-called "overflow dam or potential regulator" of Little's Automatic Chemical Telegraph. A speed above forty to sixty words a minute with a chemical telegraph has been but very seldom attained, but by inserting an adjustable slide-resistance betweeen the pen or stylus and earth, Mr. Little finds that as many as thirty thousand emissions of current may be registered per minute. The slide-resistance acts as a shunt, and permits excess of current to flow to earth, thus producing distinct marks.

TELEGRAPHIC PROGRESS IN SAN SALVADOR. — The *Official Gazette* of Salvador says:—On account of the frequent breakage of telegraph wires and the failure of the batteries the system is not yet in good working order. Certain regulations and penalties have been decreed by the Government. On telegraphic matters the Minister of the Interior, in his report to the Constituent Assembly of 1873, says that "telegraphs are now spread over the Republic, and doing much good to the country."

City and Commercial Notes.

SINCE the issue of our last number, the Globe Telegraph and Trust Scheme, notwithstanding opposition from the directors of some of the companies, seems to have been eagerly supported, for subscriptions have come in so well that the first issue of £3,000,000 will be finally closed on Tuesday next. The directors of the Submarine Telegraph Company have issued a circular, pointing out to the shareholders that any arrangement come to with the Company proposed will be greatly to their disadvantage; this circular also shows that the directors of the Submarine Company had never had any proposal submitted to them prior to the issue of the prospectus. The following is a copy of a resolution, in reply to a letter received from the Globe Telegraph Company, passed at the meeting of the board of the Indo-European Telegraph Company, held on the 7th ult.:—"Resolved,—That the directors cannot recommend their shareholders to assent to any arrangement which would return them less than the original par value of their shares, and any arrangement would have to be subject to the approval of the Governments concerned." But at a general meeting of shareholders in the various Submarine Telegraph Companies held on the 21st ult. at the Cannon-street Hotel (convened by a committee of shareholders), "for the purpose of considering the scheme of the Globe Telegraph and Trust Company, and of adopting resolutions with reference thereto," the merits of the new company were fully discussed, and it was resolved by an overwhelming majority to adopt the Globe Telegraph Amalgamation scheme; it was also unanimously agreed that Mr. William Ford should be requested to join the board as representing the shareholding interest. At the close of this meeting, which was presided over by Mr. J. H. Lloyd, Q.C., some large subscriptions were made, including one tender for £100,000. At the last half-yearly meeting of the Telegraph Construction and Maintenance Company, Sir Daniel Gooch said,—"I believe the Globe scheme to be a wise and proper scheme. I believe, by the consolidation of these various cables, we get an average security for our property, which we do not get, and cannot possibly get, by having our money invested in any one individual cable; and I believe the Globe scheme to be the means of arriving at that end."

The Brazilian Submarine Telegraph Company have notified that they contemplate establishing signal stations at several points on the coast of Madeira and St. Vincent. At these stations the International Code will be the only one recognised, and vessels of any nation which thus make their names known can be reported on payment of the semaphore and telegraph tariff. The service, it is believed, will prove extremely useful by enabling shipowners to forward messages from or to their vessels, and will be available for those bound outward or homeward from Africa, the Cape of Good Hope, and the East, on the one side, and South America and the Pacific on the other.

A telegram from Versailles states that the direct submarine cable laid down between France and Denmark is working well.

A false telegram regarding the Spanish dividend was said to have passed over the line of the Eastern Telegraph Company. The following letter, from Sir James Anderson to the *Times*, shows that the telegram did not pass over this Company's line:—

"66, Old Broad-street, E.C., July 29, 1873.

"SPANISH DIVIDEND.

"Sir,—In a letter in your Money Article this morning it is said:—'The London Telegraph Office declared that the telegram in question came from Madrid.' This is not the fact. When the telegram was shown to me yesterday it was at once evident that the Spanish language was well written, without any errors, and that the printed form had a fair general appearance of our received forms; but the spelling and the omissions were such as could not have emanated from any printer with a copy of our forms before him. The envelope was also a forgery, and it is certain no such message passed over this company's lines.—Yours, &c.,

"JAMES ANDERSON."

Our readers will agree with the *Times*, when it says that the fact of a deliberate plan of telegraphic fraud having been carried out by means in which it was necessary to use the printing process and to obtain a special kind of paper, furnishes a further warning to the public of the absolute necessity of never assuming a telegram to be true which bears upon any important interests until they shall have telegraphed to the alleged sender for confirmation of the contents. About eight months back, when the Stock Exchange were imposed upon by a false notification of the Midland Company having taken over the Sheffield, and fluctuations were caused to the extent of 4 per cent, the necessity of this precaution was strongly enforced, and in the year 1871 a similar lesson was taught by the receipt of a false message from America of a large steamer with a telegraph cable on board having foundered—a deception which caused losses at Lloyd's, and a temporary depreciation in the value of many telegraph securities. In formal business matters the use of a verification cipher may be considered a satisfactory general precaution; but as it is possible for a cipher to be discovered, especially by that ingenious and persevering class who devote to the purposes of crime abilities which honestly applied would bring them any amount of wealth, there can be no perfect safeguard, except in a direct inquiry addressed to the sender. In the case of the Spanish telegram it seems that the financial agent did not deem it requisite to resort to a check of any kind.

A special meeting of the United Kingdom Electric Telegraph Company was held on Tuesday, the 15th ult., at the London Tavern; Mr. H. H. Croll in the chair. The chairman read the financial statements of the liquidators, by which it appeared that up to the present time they had paid £7 13s. on every £5 share, and the money now in hand would enable them to distribute another 1s. 4d. per share, leaving £160 in hand to defray the cost of printing the statement, and posting a copy to every shareholder. Lord A. Churchhill moved, "That the accounts of the liquidators be adopted, and that the 1s. 4d. per share be paid." Mr. Andrews seconded the resolution, which was agreed to.

The liquidators of the French Atlantic Cable Company have given notice that, the fusion of that company with the Anglo-American Company being completed, they will at once proceed with the distribution of the Anglo-American stock to which the shareholders are entitled, viz., £36 stock for each £20 share. It is also announced that all the liabilities, including the debenture debt, of the French company are now provided for.

Advices have been received from the West India Islands that the Telegraph Construction and Maintenance Company's ship *Investigator* has successfully recovered and buoyed the Jamaica and Porto Rico section of the cable, about 30 miles from Porto Rico. The *Investigator* signalled to Jamaica, a distance of some 600 miles—a fact which shows that this section of the line is in good working order.

It is understood that the liquidators of the French Atlantic Cable Company have just paid the Telegraph Construction Company the sum of £40,0000, being the amount due on the completion of the main Atlantic line and the two lines from Placentia (Newfoundland) to Sydney (Nova Scotia).

The Eastern Telegraph Company, limited, have notified the completion of their duplicate communication with Portugal by a cable from Vigo to Lisbon.

An extraordinary meeting of the Cape of Good Hope Telegraph Company, Limited, will be held on the 5th inst., for the purpose of passing special resolutions to the following effect:—1. That the Company be wound up voluntarily. 2. That Mr. William Quilter be appointed liquidator for the purpose of winding up the affairs of the Company and distributing its property."

At the Board Meeting, on Friday last, of the Anglo-American Telegraph Company, Limited, Captain Hamilton resigned, in favour of Lord Monck, late chairman of the French Atlantic Telegraph Company, the position of chairman, accepting himself that of deputy chairman.

The half-yearly meeting of the Telegraph Construction and Maintenance Company, Limited, was held on Tuesday, the 22nd ult., at the London Tavern. Sir Daniel Gooch, Bart., M.P., the chairman, congratulated the meeting on the successful laying of another Atlantic cable, there having been no hitch whatever in the operation. The great ship performed the duty, as she always has done, well and efficiently; and it shows the importance of that big ship, for the other two large ships—and they were both large—were unable to keep up with her. If the cable had been in the other ships they would have had to cut it in the gale, and a considerable amount of risk and delay would have occurred. The work in hand consists chiefly of the Brazilian cable. The portion between Lisbon and Madeira will be laid very shortly, also the other portion will be laid in the course of this year, and the other section—about 2000 miles—will be laid early in the spring. No accounts were submitted, but the chairman expressed a hope that when the yearly accounts were made up, a satisfactory result would be shown. Speaking of the picking up of the 1865 cable, Sir Daniel Gooch said:—"Our contract for doing that work is no secret, for other companies have published it. We shall be paid in money, £60,000 for the operations, and that covers a certain number of days at £1,500 a day; beyond that, if we succeed in restoring the cable, we are to be paid £150,000 in gross. We believe that is an admirable arrangement for the cable companies, and, if we succeed, it will be a very beneficial arrangement for us." The *Great Eastern* has already sailed from Heart's Content to repair the 1865 cable.

NEW JOINT-STOCK COMPANIES.

The following new Companies have been registered in accordance with the provisions of the Limited Liability Act:—

The Newfoundland Land Company, Limited. Capital £150,000, in £3 shares.—This Company has been formed with the primary object of taking the place of the New York, Newfoundland, and London Telegraph Company, for all purposes except the ownership of the property intended to be taken over by the Anglo-American Telegraph Company, Limited. The subscribers are—Cyrus W. Field, New York, 20 shares; James Anderson, 26, Old Broad-street, 20 shares; Henry Weaver, 26, Old Broad-street, 20 shares; John Grant, 26, Old Broad-street, 20 shares; T. H. Wells, 26, Old Broad-street, 20 shares; E. L. S. Benzor, 34, Old Broad-street, 20 shares; and A. S. Hay, 25, St. John's-wood-park, 10 shares.

The Spanish and Cuban Submarine Telegraph Company, Limited.—Capital £2,500,000, in £10 shares. It is intended by this Company to put down a submarine cable, starting from the West Coast of the Spanish Peninsula, through the Canary Islands, uniting those of Teneriffe and Gran Canaria, and terminating in Cuba. The subscribers (who take one share each) are—A. K. Mackinnon, Belgrave-mansions; P. R. Innes, 59, St. George's-square; W. S. Ferris, 31, Cornwall-road, Bayswater; F. L. de Lara, Grosvenor-gardens; J. E. Clinto, 9, Austinfriars; Charles Jackson, 133, Harley-street; and J. G. Turney, 9, Austinfriars.

The Black Sea Telegraph Company, Limited. Capital £150,000, in £10 shares.—This scheme is promoted for the purpose of obtaining concessions for the construction of a cable between various ports on the Black Sea. The subscribers are—Sherard Osborne, 6, Gloucester Terrace, Hyde Park, 20 shares; Philip Rawson, Woodhurst, Crawley, 20 shares; Spencer Chapman, 12, Chester Square, 20 shares; H. G. Erichsen, 7, Great Winchester Street, 20 shares; R. C. Halpin, Queen's Hotel, E.C., 20 shares; Carl F. Tietgen, Copenhagen; G. M. Clements, Gresham House, 10 shares; and Daniel Gooch, 3, Warwick Road, 20 shares.

TELEGRAPH SHARE LIST.

Amount per Share.	Name of Company.	Amount paid up.	Closing Quotations.
£		£	July 30
Stock	Anglo-American (Limited)	100	135—138
10	Brazilian Submarine	7	2—1½ dis.
10	Cuba	All	9¼—9¾
10	Direct Spanish	9	½dis.—½pm
20	Direct United States Cable	8	4—2 dis.
10	Eastern (Limited)	All	9—9¼
10	Ditto New	All	8⅞—9⅛
10	Eastern Extn. Australia and China	All	8¾—9
10	Great Northern	All	9¾—10¼
25	Indo-European	All	16—18
10	Mediterranean Extension (Limited)	All	5½—6
10	Do., 8 per cent Pref...	All	11—12
20	New York, Newfoundland, and London	All	20—20½
8	Reuters	All	10½—11½
20	Société Transatlantique Francaise..	All	32—32½
Stock	Submarine	100	225—235
1	Do., Scrip	All	2¼—2½
10	West India and Panama	All	6¾—7
10	Do., 10 per cent Pref.	5	½—1 pm.
1000 dls.	West Un. U.S. 7 per cent 1st M.B.	All	91—93
10	Hooper's Telegraph Works	All	12¾—13¼
50	India-Rubber and Gutta Percha ..	All	32—33
Cert.	Submarine Cables Trust	100	110—114
12	Telegraph Construction	All	32¾—33¼
100	Ditto Ditto 7 per cent Bonds	100	102—105

British Association for the Advancement of Science.—The next annual meeting of this Association will be held at Bradford, commencing on the 17th of September. Ill health has rendered it impossible for Dr. Joule to preside. Dr. A. W. Williamson, F.R.S., will therefore preside. The vice-presidents elect are the Earl of Rosse, F.R.S.; Lord Houghton, D.C.L., F.R.S.; Mr. W. E. Forster, M.P.; the Mayor of Bradford; Mr. J. P. Gassiott, D.C.L., F.R.S.: Prof. Phillips, D.C.L., F.R.S.; Mr. John Hawkshaw, F.R.S., F.G.S. The Local Secretaries for the Bradford Meeting are—The Rev. J. R. Campbell, D.D.; Mr. R. Goddard; and Mr. Piele Thompson. Section A. (Mathematical and Physical Science) will be presided over by Prof. Henry J. Stephen Smith, LL.D., F.R.S.; Prof. W. K. Clifford, M.A., J. W. L. Glaisher, Prof. A. S. Herschell, and Prof. Forbes, acting as Secretaries.

To Correspondents.

⁂ The publisher, having received numerous letters complaining of the irregular supply of the Journal by Newsagents, begs to state that it will be sent direct from the Office on the day of publication, post free, on receipt of Annual Subscription of 9s. by Post-Office Order.

W. Kimberlake.—Messrs. Bolton and Co., of Holborn Bars, would supply the materials you require.

A. Jenkin.—Read the article in the "Quarterly Journal of Science" for July. See p. 225.

Operator.—The consumption of material is nearly nil, because there is only tendency to action, and not continued action. When sufficient electricity has been provided to maintain the equilibrium no more metal is dissolved.

Student.—The particulars of the prizes for electrical subjects offered by the Society of Arts will appear in our next.